TABLE 3.—*Maximum free-air wind velocities (m. p. s.), for different sections of the United States based on pilot-balloon observations during January 1943*

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m) m. s. l.	Date	Station
Northeast [1]	46.8	nw.	1,550	21	Caribou, Me.	49.7	nw.	3,050	21	Portland, Me.	90.5	w.	13,550	29	Portland, Me.
East-Central [2]	46.8	wnw	2,500	4	Knoxville, Tenn.	62.4	w.	5,000	4	Greensboro, N. C.	69.0	sse.	8,210	13	Washington, D. C.
Southeast [3]	37.2	wnw.	2,500	10	Jacksonville, Fla.	48.0	wnw.	4,150	10	Jacksonville, Fla.	52.0	w.	8,030	20	Tallahassee, Fla.
North-Central [4]	45.6	w.	2,150	22	Rapid City, S. Dak.	53.4	wnw.	3,310	5	International Falls, Minn.	62.0	nnw.	7,120	11	Fargo, N. Dak.
Central [5]	49.2	sw.	1,580	15	Kansas City, Mo.	52.0	nw.	4,720	14	North Platte, Nebr.	75.2	wnw.	14,700	10	Wichita, Kans.
South-Central [6]	44.2	wnw.	2,160	9	Little Rock, Ark.	41.6	wsw.	2,900	16	Texarkana, Ark.	113.0	sw.	17,090	23	Amarillo, Tex.
Northwest [7]	49.0	wnw.	1,260	15	Pendleton, Oreg.	60.0	wnw.	3,700	15	Burns, Oreg.	80.0	nw.	10,720	18	Boise, Idaho.
West-Central [8]	60.8	w.	2,480	20	Cheyenne, Wyo.	67.0	wnw.	4,700	15	Ely, Nevada	70.0	nw.	12,920	18	Ely, Nev.
Southwest [9]	39.2	w.	2,370	16	El Paso, Tex.	42.6	wnw.	5,000	18	Albuquerque, N. Mex.	62.8	nw.	8,700	25	Tucson, Ariz.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

RIVER STAGES AND FLOODS

By BENNETT SWENSON

Precipitation during January 1943 was extremely heavy in most sections west of the Rocky Mountains, while in the central interior sections of the country extremely dry conditions prevailed. Nevada and California had the wettest January since 1916, although parts of southern California were very dry during much of the month. Montana had more precipitation than in any January since 1909 and North Dakota, since 1933. On the other hand, Oklahoma, Missouri, Arkansas, and Iowa were the driest of record, Oklahoma having an average of only 0.08 inch during the month.

There were marked changes in temperature in January, alternating between very warm and very cold over much of the country. The mean temperature for the month was below normal across the northern third of the country and above normal in most of the remainder of the country.

Floods occurred during the month in California, Oregon, Nevada, and portions of the Southeast. The flood which originated during December in the Ohio River Basin, crested at Marietta, Ohio, on January 1 and reached the mouth of the Ohio by January 11.

St. Lawrence drainage.—Considerable snow has accumulated in the upper Lakes Region, the snow cover at the end of the month ranging from about 3 inches in southern Michigan to over 3 feet in northern Michigan and Wisconsin. The total snowfall for the winter season through January at Lansing, Mich., was about 47 inches, which represents more than the average total fall for the entire winter season.

A rise occurred in the Grand River at Grand Rapids, Mich., on January 17, due to an ice jam, but flood stage was narrowly averted.

Atlantic slope drainage.—The snow cover at the end of January extended as far south as Maryland and northern Virginia. Maximum depths of more than 3 feet were found in northern New York and New England. Ice in the rivers ranged from about a foot in northern Connecticut to over 2 feet in northern Maine. Mostly floating and shore ice were reported in eastern Pennsylvania, while in the Hudson River at Albany, 10 inches of ice was observed.

Heavy rains on January 18–19 and again on January 27–28, caused light to moderate floods in most of the streams from North Carolina southward.

Rains averaged about 2 inches over the Yadkin and upper PeeDee River basins on the 18th–19th and a moderate flood occurred in the PeeDee, cresting at 33.8 feet at Cheraw, S. C., on the 20th. On the 27th–28th an average of about 2.5 inches of rain occurred in the upper Yadkin Basin. This time Cheraw, S. C., crested at 34.7 feet on the 29th.

In the Santee River basin, average rainfall amounts in the two storm periods were as follows: Saluda River, 4.45 inches on the 18th–19th and 2.92 inches on the 27th–28th; Broad River, 3.32 and 3 inches; Catawba-Wateree River, 2.46 and 1.75 inches. Floods were mostly light with little damage resulting.

An average of 2.25 inches of rain in the Savannah River basin on the 18th–19th resulted in a crest stage of 33.3 feet at Augusta, Ga., on the 20th. Further rains on the 28th caused another slighter rise. Damage was light.

Sharp rises occurred in the upper Ocmulgee and Oconee Rivers from the heavy rains on the 18th–19th, which averaged 4.5 inches above Macon, Ga., and 3.4 inches above Milledgeville, Ga. Unusually heavy rains of over 7 inches fell at Hawkinsville and Dublin, Ga., in the middle portion of the basin, within 24 hours. The Oconee River crested at Macon on the 20th at a stage of 22 feet, 4 feet above flood stage, and the Ocmulgee River crested at Milledgeville on the same day at 28.4 feet, 8.4 feet above flood stage.

Another, but a lesser, rise occurred from the further rains on the 28th. However, stages in the lower reaches were already high and only slight rises occurred at the lower stations.

Flood stages were exceeded at all points in the Altamaha River system, except at Doctortown on the Altamaha. Slight damage was caused by the flood in the middle and lower reaches of the basin.

East Gulf of Mexico drainage.—Heavy rainfall from January 17–19, averaging 4 to 5 inches over northern and middle portions of the Chattahoochee River basin resulted in flood stages at all points south of Columbus and Montezuma, Ga. The Flint River crested at Albany, Ga., on the 22d at a stage of 32 feet, 12 feet above flood stage. At Eufaula, Ala., the Chattahoochee River reached

a crest of 48 feet on the 20th, 8 feet above flood stage. Considerable damage resulted from the overflow.

Slight flooding occurred in the middle Conecuh River from rains averaging 5.7 inches and moderate floods in Choctawhatchee River resulted from an average rainfall of 3.1 inches. The heavy rains fell on the 17th–18th. The damage from the flooding was moderate.

Ohio Basin.—The Ohio River flood which began during the latter part of December maintained moderately high flood proportions throughout the length of the Ohio River. Crest stages reached are given in the table of flood stages at the end of this report. A complete report of this flood will be given in a later issue of the REVIEW.

The Great Basin.—The following report is submitted by the Weather Bureau office, Salt Lake City, Utah, relative to storms and floods in Nevada:

An intense storm, which covered the entire State from January 20–23, was accompanied by high winds, and in northern, western, and southwestern areas by excessive precipitation. Due to unusually warm temperatures in the valleys and lower watersheds, much of the heavy precipitation came as rain or melting snows. Totals for the storm and maximum amounts in 24 hours were especially heavy in parts of the upper Humbodt, Carson, and Truckee Basins and at many other scattered points in northern and southwestern counties. Stations reporting 24-hour maximum precipitation exceeding 2 inches were as follows, in inches: Marlette Lake, 4.35; Lewers Ranch, 3.60; Carson City, 2.56; Reno Airport, 2.37; Minden, 2.32; and Goldfield, 2.10.

Rather heavy and destructive floods resulting from rapid run-off did considerable damage in the upper Humbodt Valley, especially near Elko, at many places in Washoe County, including the Truckee Basin, and also in the Carson Basin and in Humboldt County, near Orovada. The principal damage appears to have been from the washing out of highways, bridges, irrigation dams, and laterals. Important, but somewhat lesser losses were incurred by flooding and the interruption to communications and commercial traffic. The heavier losses appeared to have been incurred in Lyon, southern Washoe, and west-central Elko Counties. The total estimated losses for the State total about $90,000, mostly from the action of floods, since wind damage apparently was quite minor.

Pacific slope drainage.—Unusually heavy rainstorms on January 19–23 caused considerable damage from flooding in both northern and southern California during the month. The Sacramento River rose above flood stage. At Sacramento, the maximum stage was 28.8 feet, compared with 28.5 in 1940. The heaviest rains occurred in the basins of the Bear and American Rivers and the high stage at Sacramento was due to the excessive run-off from the American River. The stages on the Bear and American Rivers were the highest since 1928, and in some cases the highest of record.

In Southern California, the rainfall on January 21 and 22 exceeded that of the March 1938 storm in some cases. However, very dry conditions prevailed prior to the storm of January 21–22 and the run-off was generally less than in 1938. Considerable damage was caused by the flooding in some cases, one instance being in Lytle Creek in the vicinity of San Bernardino.

Kings River, in the San Joaquin Basin, was at unusually low stages until the 22d of the month. Heavy rains at high elevations on the 21st caused a sharp rise in that river on the morning of the 22d, cresting at 16.2 feet at Piedra, Calif. Some lowlands were flooded but only minor damage resulted.

One of the worst floods of record occurred in the Eel River basin on January 20–23, the peak of the rise reaching Fernbridge, Calif., about midnight of the 21–22d. The crest stage was about 25 feet, compared to 24.4 feet in 1940 and about 25 feet in 1937.

A series of damaging floods began in the Willamette River basin in November and continued until the first part of January. November and December were unusually wet, the precipitation in the Williamette Basin during the two-month period being 187 percent of normal.

Snow depths increased during the month in Washington, especially in the mountains, and were much above normal. In the northeastern part of the State, there has been snow on the ground at the lower elevations since November. Temperatures remained below normal and there was little run-off from melting snow.

The following report of the floods in the Sacramento River Basin was prepared at the Weather Bureau office, Sacramento:

The first 3 weeks of January 1943 were rainless and unusually cold. By January 19 the rivers of the Sacramento River district had fallen to very low stages. Rainfall was below normal at all points and the snow pack in the mountains was very light giving rise to considerable anxiety regarding a possible water shortage for the summer.

During the night of January 19–20, the first of a series of fronts moved inland over the district. Because of the cold air then present in northern California precipitation was in the form of snow down to very low elevations with reports showing as much as 16 inches on the ground at Redding by noon of the 20th. As cyclonic conditions increased, the continued inflow of warm air caused gradually increasing temperatures and by afternoon of the 20th precipitation was in the form of rain to moderately high elevations. The storm continued with increasing winds and high rainfall until the passage of an occluded front brought a temporary respite during the early evening of the 21st, but barometers continued at almost record low levels. A second series of frontal passages began early on the 22d and during that night moderately heavy rain occurred over most of the district. Rainfall for the storm period, at selected stations, is shown in table 1. This rainfall has been separated into two storm events, one of about 36 hours' duration from early morning of January 20 to the afternoon of January 21, and the other of 24 hours' duration from 7 a. m. January 22 to 7 a. m. January 23.

TABLE 1.—*Precipitation at selected stations, January 20 to 23, inclusive*

Station	Basin	January			Total	Percent of annual normal	Jan. 23	Percent of annual normal
		20	21	22				
Folsom	American	0.36	1.60	1.77	3.73	15.5	1.30	5.4
Pacific	do	.75	4.78	4.01	9.54	25.0	2.53	6.7
Georgetown	do	.58	2.01	2.25	4.84	8.8	1.87	3.4
Challenge	Yuba	.74	6.00	2.52	9.26	13.4	2.70	3.9
Camptonville	do	.70	5.70	2.47	8.87	14.4	3.08	5.0
Downieville	do	1.12	6.36	5.00	12.48	20.2	3.45	5.6
Oroville	Feather	.60	1.96	1.24	3.80	14.1	1.00	3.7
Bush Creek	do	1.40	6.65	3.35	11.40	16.5	4.20	6.1
Stirling City	do	1.00	6.08	2.40	9.48	13.8	4.25	6.2
Mineral	Deer	.95	5.45	3.25	9.63	19.7	2.58	5.3
Volta*	Battle	1.40	2.15	.72	4.27	13.6	1.95	6.2
Paskenta	Thomas	.50	1.71	.64	2.85	14.8	1.48	7.7
Stonyford	Stony	1.25	2.30	.87	4.42	23.2	1.36	7.2
Clear Lake	Cashe	.63	3.18	1.45	5.26	23.0	1.40	6.1
Hobergs	Putah	1.98	7.19	2.53	11.70	24.0	4.23	8.7
Dunsmuir	Sacramento	3.25	2.89	2.00	8.14	16.7	1.55	3.2
Vollmers	do	1.90	5.02	1.08	8.00	12.5	1.72	2.7
Red Bluff	do	1.10	1.93	.67	3.70	16.5	1.46	6.5
Hamilton City	do	.56	1.14	.61	2.31	11.7	1.15	5.8
Knights Ldg	do	.38	1.40	1.05	2.83	17.1	1.18	7.1
Sacramento	do	.27	1.74	2.30	4.37	25.6	1.16	6.8
Bensons Ferry	Mokelumne	.35	.82	1.08	2.25	15.3	.96	6.5
Tiger Creek*	do	1.83	4.80	1.59	8.22	17.6	2.04	4.4
Salt Springs*	do	2.08	4.97	1.96	9.01	21.0	2.58	6.0

*4 p. m. observations, all others 7 a. m.

It was the first of these two storm events that was most spectacular and most damaging. The severity of the rain is shown by the percentage of annual normal which fell within the 36 hours. Since precipitation during the first 12 hours was largely in the form of snow, the run-off from the storm was concentrated in a 24-hour period. At many river stations within the district the stages rose from the lowest to the highest for the month in little more than 24 hours, with some stations reaching near record crests (table 2). The storm which followed, resulted in a secondary crest at headwater stations and served to slightly increase the resultant crests at lower river points. No additional flooding or damage occurred as a result of the secondary peak.

The storms, traveling south of the more customary storm track, struck most heavily on the basins of the Bear and American Rivers. At Folsom, the American River reached a crest, exceeded only by the floods of 1907 and 1928, while at Wolf on the Bear River, pre-

TABLE 2.—*Crest stages of important floods in Sacramento Basin.*

Station	March 1907	January–February 1909	February 1915	March 1928	April 1935	February 1936	December 1937	February–March 1940	March–April 1940	February–March 1941	April 1941	January 1942	February 1942	January 1943	Highest of Record (to 1943, inclusive)
Kennett	33.2	32.5	29.5	23.0	14.0	21.8	29.0	36.3	23.1	17.4	19.7	18.3	20.9		36.3, Feb. 28, 1940.
Vollmers							19.5	27.3							
Red Bluff	26.8	30.5	30.4	26.9	23.6	25.4	32.0	32.2	28.0	25.6	26.2	23.8	28.6	26.8	32.2, Feb. 28, 1940.
Tehama	220.0		222.6							219.1	219.4		221.4	218.6	
Hamilton City				22.0	18.8	20.4	22.8	22.6	20.8	20.6	20.1	18.6	21.8	19.1	22.8, Dec. 11, 1937.
St. John	13.2	12.6	11.5	7.6	4.5	6.2	12.0	13.9	5.4	12.4	10.3	7.8	9.5	9.3	13.9, Feb. 28, 1940.
Ord Ferry						115.4	121.0	121.6	119.1	119.0	118.8	117.1	121.2	118.1	
Colusa	29.3	28.0	28.8	25.7	25.6	26.0	26.8	29.5	26.2	27.1	26.7	25.9	28.6	26.0	29.5, Mar. 1, 1940
Knights Ldg	32.2	31.1	30.9	31.2	30.2	31.0	32.6	34.0	31.7	32.2	30.9	31.5	34.0	31.8	34.0, Mar. 1, 1940.
Las Plumas	493.0	489.0		481.6		471.7	481.0	479.4	478.0	472.6		471.2	474.4	472.2	
Oroville	28.2	26.0	12.8	26.1	14.3	17.7	26.3	25.1	24.1	18.0	11.6	15.5	20.0	18.7	28.2, Mar. 19, 1907.
Colgate	23.0	19.5	7.2	21.0	11.0	13.0	22.0	14.8	15.3	12.8	4.7	12.2	12.5	17.7	23.0, Mar. 18, 1907.
Marysville	73.8	74.4	65.9	74.5	66.5	69.0	76.2	75.5	76.0	67.4	61.7	66.8	70.0	68.2	76.2, Dec. 11, 1937.
Nicolaus			18.9	23.2	20.5	21.2	24.6	26.3	25.6	22.9	19.4	21.9	25.1	22.0	26.3, Feb. 29, 1940.
Wolf				[1] 13.8			[1] 10.3					8.2	9.0	[1] 14.0	
Rattlesnake Bridge					17.6	16.6	[1] 25.9		21.5		8.5	18.8	12.7	26.5	
Coloma					16.8	16.5	20.5		18.1		17.5	20.7	13.0	22.4	
Folsom	26.8	24.5	12.4	26.8	18.8	18.4	23.9	19.1	21.9	14.5	11.9	20.3	14.7	26.0	26.8, Mar. 19, 1907 and Mar. 25, 1928.
H St. Bridge				43.4	39.0	29.0	41.9	39.2	41.6	34.5		40.0	36.4	42.5	43.4, Mar. 25, 1928.
Sacramento	26.9	29.6	25.4	29.5	28.6	28.7	27.7	28.5	28.5	27.3	25.8	28.3	27.6	28.8	29.6, Jan. 17, 1909.
Michigan Bar	16.3	10.5	7.5	11.0	10.4	9.9	7.6	8.3	11.7			11.2			16.3, March 1907.
Bensons Ferry	14.5		11.0	13.8	11.4	14.3	4.9	13.3	15.5	9.5	10.5	14.7	12.1	14.3	15.5, April 1, 1940.
La Grange				9.3	5.3	4.5		5.4	8.5						9.9, Jan. 18, 1921.
Lathrop	19.2	18.7	12.9	16.4	12.8	15.3	5.2	14.4	16.6	15.4	11.8	7.1	10.1		22.5, Feb. 1, 1911.[2]

[1] Approximately.

[2] 20.7, Mar. 17, 1938.

liminary reports indicate the crest may have exceeded that of 1928. At Wheatland on the Bear River a crest of 18.0 feet was reported to be 3 feet higher than any previous record. Elsewhere crests were not unusually high, in most cases ranking approximately as the seventh highest of the past 40 years. Unquestionably, however, it can be called the greatest flash flood of record during this century in the Sacramento Valley. On no other occasion has a flood of this magnitude developed from low water to crest in a period as short as 24 hours.

Damage was relatively light throughout the district. An important factor in conserving losses was the general warnings given to stockmen, permitting the removal of livestock from the bypasses and lowland areas, which, on account of antecedent low water were being more extensively pastured than usual in midwinter.

Overflow occurred as follows:

East side Sacramento River from Red Bluff to below Hamilton City.—Overflow normally occurs here nearly every year. The land is used primarily for grazing and little damage is reported.

Reclamation District 1001 on the Lower Bear River.—A levee break inundated a portion of this district requiring the evacuation of about 100 families. Damage was primarily restricted to dwellings and farm equipment. Red Cross workers from Yuba City and soldiers from Camp Beale rendered splendid service in evacuation of the flooded area.

American River from the vicinity of Sierra Oaks to the mouth.—The lowlands outside the Sacramento and Northern Sacramento levees were flooded. The damage was principally to dwellings and farm buildings. Damage was increased by the failure of a minor levee above H Street Bridge. The break did not increase the flooded area over what is normally covered at the stages which occurred but the suddenness of the break caused flooding before residents had ample opportunity to complete preparations. About 30 families were affected in this area.

Liberty Island, Prospect Island, and Little Holland Tracts in Yolo Bypass.—These farm tracts in Yolo Bypass are protected by substandard levees and flooding is expected whenever moderately high overflow occurs at Fremont Weir. The owners had ample warning and little damage was reported, except to levees and prospective crops.

FLOOD LOSS STATISTICS

1. Damage to tangible property, including buildings, equipment, land, roads, levees, etc	$225, 700
2. Damage to crops, actual and prospective, involving 18,650 acres	141, 200
3. Value of livestock lost	500
4. Loss of income and suspension of business, including wages of employees	9, 500
Total loss	376, 900
5. Money value of property saved by flood warnings (incomplete estimate)	31, 000

6. No loss of life was reported, but it is believed that some lives were saved as result of warnings issued.

Frequent and damaging floods occurred in the Willamette River and tributaries from November 23, 1942, to January 8, 1943. The Weather Bureau office, Portland, Oreg., submits the following report relative to the floods:

The rainy season began on October 30th when the first of a series of storms moved across Oregon. The storms became more intense by November 21, when a series of occlusions moved across the Pacific Northwest at intervals of about 24 to 36 hours, with frontal systems moving across on November 21, 22, 23, 24, 26, 28, 30, and December 1. The systems of November 28 and December 1 moved relatively slowly and were attended by widespread, warm-frontal rains over the Northwest. High pressure moved inland during December 2 and 3, but by the evening of the 4th pressures again began to fall over the Northwest, with the first of a family of systems moving across the Pacific Northwest on the 5th.

Successive systems moved inland over the Northwest on the 6th, 7th, 8th, and 9th and were again followed by high pressure, which spread over the western third of the country by the 10th. A weak trough passed over the Northwest on the 12th with rains limited to the region of the Cascades westward. High pressure dominated the western half of the map from the 13th to the 19th, causing the storm track to shift toward the north. On the evening of the 19th the first of a series of lows, with centers moving just north of Vancouver Island and occluding frontal systems extending southward to California, were noted.

Systems followed with a period of approximately 36 to 48 hours on the 20th, 21st, 23d, 24th, 26th, and 29th. The trough of the 29th moved slowly and was followed by secondary storms forming as waves on the discontinuity just off the Oregon coast on the 30th and again on the 31st. The last two systems formed directly off the Oregon coast and their attendant precipitation areas were widespread, warm, and heavy in amounts, especially from the Cascades westward.

High pressure accompanied by low temperatures moved inland on the 1st and 2d of January and stagnated over the Great Basin, bringing to an end an exceedingly stormy two months over Oregon.

August, September, and most of October were dry, and some new low-water records were established. Because of this the heavy rains which began on October 31 and continued at frequent intervals until January 2, required considerable time to bring any of the streams to flood stage.

November and December were unusually wet. For Oregon as a whole November was the second wettest of record and December the wettest of record, more than 47 percent of the year's precipitation having occurred in the 2 months. In this 2-month period the precipitation in the Willamette drainage basin was 187 percent of the normal. Including January 1, 1943, the average precipitation for stations in this basin was 32.59 inches. Precipitation at selected stations is given in table 3.

As previously indicated, the floods were not the result of a single outstanding storm, but of a prolonged wet period. At times melting snow in the foothills was a contributing factor, but at no time was there large run-off from high snow. Mountain snow storage at the